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A STUDY OF LAND USE ACTIVITIES AND THEIR RELATIONSHIP TO THE SPORT FISH RESOURCES IN ALASKA

D-I-A&B

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Annual Performance Report for

ESTABLISHMENT OF GUIDELINES FOR PROTECTION OF THE SPORT FISH RESOURCES DURING LAND USE ACTIVITIES

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Job Title: Establishment of Guidelines for Protection of the Sport Fish Resources During Land Use Activities.

Cooperators: S. T. Elliott and D. J. Hubartt

Period Covered: July 1, 1983 to June 30, 1984

ABSTRACT

The winter survival of rearing salmonids is considered by managers to be the most important aspect of the influence of timber harvest on salmonid production. The Alaska Working Group on Cooperative Fishery-Forestry Research, of which this project is a member, initiated a study to compare winter survival and movement of rearing fish in clear-cut and forested sections of streams and clear-cut and buffer zone sections of streams. The study also examined the value of ponds and sloughs as "refuge habitat" during the winter months and will attempt to determine the rate of smoltification of juveniles from these areas.

Movement of juveniles occurred mostly between August and November with most of the movement being local, e.g., immediately upstream or downstream. However, juvenile coho (Oncorhynchus kisutch) living in the estaurine zone move upstream and disperse throughout the watershed. Rates of survival were highest (73% - 100%) for fish living in old growth forested stream sections and for fish wintering in sloughs and ponds. The survival rate of fish wintering in clear-cuts was the poorest (29% - 70%) and intermediate in buffer zones (40% - 86%).

The issue concerning the fate of coho fry in logged streams (Elliott, 1983) cannot be addressed until smolt work is completed in June 1984. Those results will be included in future reports.

* This report is numbered for the sake of consistency, however, this project received no federal dollars this year.

The results of this study are preliminary, pending further analysis.

KEYWORDS

Clear-cut logging, winter survival, seasonal movement, Dolly Varden char, Salvelinus malma (Walbaum), coho salmon, Oncorhynchus kisutch (Walbaum), cutthroat trout, Salmo clarki Richardson.

BACKGROUND

Since its inception in 1970, the Land Use Project of the Sport Fish Division has investigated many aspects of forest development and documented its impact on rearing fish habitat. The project has also been active in providing data and documentation for prescriptive guidelines to reduce the impact of timber harvest on stream habitat. By 1980, however, it became apparent that fishery managers needed more specific data regarding the influence of timber harvest on rearing species; measurement of changes in habitat alone was inadequate in explaining the influence of clear-cutting on fish abundance and productivity.

In 1982, the project measured and compared the quality of habitat and abundance of rearing salmonids in nine streams that had been clear-cut in the 1960's to habitat and abundance in nine forested streams. Elliott and Hubartt (1983) concluded that:

1. There was no difference in the standing crop of age-1 coho salmon in logged and forested streams, but that there were significantly more fry (age-0) in logged streams.

2. The standing crop of Dolly Varden was significantly greater in logged streams than in forested streams.

3. The mean length of each age group of Dolly Varden and coho parr was significantly greater in the logged streams.

4. Important habitat features such as undercut banks were lacking in logged streams, which can be attributed to cross-stream logging and yarding.

5. Habitat preference of juveniles was different in logged and forested streams. In logged streams, coho are more dependent on pools, while in forested streams, fish are more associated with the total stream area.

6. Large organic debris derived from the surrounding forest was the key element in the formation of pool habitat and under-cut banks.

7. Logging to the edge of stream banks eliminates reserves of future debris needed for habitat formation and may cause a long term deterioration of habitat and loss of juvenile coho production.

The disparity in the difference of coho fry abundance and parr abundance suggests that fry may suffer greater rates of winter mortality in logged streams. Bustard and Narver (1975) and Tschaplinski and Hartman (1983) show that winter is the most critical period for rearing salmonids. Because guidelines for logging near streams are based on the summer habitat requirements of juveniles, they may be inadequate by not addressing how clearcutting affects salmonids during this most critical period. To answer these questions, the Land Use Project joined a cooperative program to examine the effects of clearcutting on winter mortality, winter habitat, and smolting rates of rearing salmonids.

A list of common names, scientific names, and abbreviations of all species mentioned in this report is presented in Table 1.

Table 1. List of Common Names, Scientific Names, and Abbreviations.

Common Name	Scientific Name and Author	Abbreviation
Coho salmon	*Oncorhynchus kisutch* (Walbaum)	SS
Dolly Varden	*Salvelinus malma* (Walbaum)	DV
Cutthroat trout	*Salmo clarki* Richardson	CT

RECOMMENDATIONS

Recommendations for management and research will be presented in the FY 85 Annual Report of Performance or upon completion of smolt work and data analysis.

OBJECTIVES

The effects of clear-cut logging on the survival of juvenile coho salmon during winter has long been considered a research goal of high priority, but because of the difficulty and expense of this type of study, no single agency has had the resources to carry out the program. In May, 1983, the Alaska Working Group on Cooperative Forestry-Fisheries Research formulated a multi-agency program to study winter survival of juvenile coho salmon and other rearing salmonids.

The general objectives of the working group are:

1. Determine if there is a difference in the winter survival rates of rearing salmonids in clear-cut and forested sections of streams.

2. Describe and evaluate the contribution of winter habitat to the rate of survival.

3. Determine if rearing salmonids leave clear-cut sections and reside in more favorable environments (refuge habitat) during the winter.

4. Determine the smolt production from clear-cut, old-growth, and refuge habitat.

5. Determine the age and size composition of smolt from clear-cut, old-growth, and refuge habitat.

Each agency was assigned specific tasks within the larger study design. The responsibilities of the Land Use Project as reported in the FY 84 Job Description are as follows:

1. Determine the production of age-0 and age-1 coho salmon from July through October in selected study streams.

2. Determine the type of habitat used by age-0 and age-1 coho during the summer months.

3. Determine the production of coho smolt in selected study streams.

The above objectives will not be addressed specifically in the following report. Only the over-all study results, which includes the above, will be discussed.

TECHNIQUES USED

Study Sites

Two sites were chosen for study: Kake Bake Creek on Kupreanof Island and Deer Track Creek located on Prince of Wales Island.

Kake Bake Creek is located approximately 24 km S.E. of Kake, Alaska and flows into Big John Bay. The stream is dystrophic, drains a small beaver dam complex, varies in width from 1 meter in the upper headwaters to about 10 meters near the mouth (Fig. 1). The stream has a large ecotone and high tides often advance a considerable distance upstream. The upper half of the watershed has been clear-cut logged.

Deer Track Creek is located about 3.2 km south of Sarheen Cove (56° 03' N, 133° 16' W) and flows into El Capitan Passage (Fig. 2). The stream is dystrophic, drains extensive sloughs and a small lake, is about a meter in width in its headwaters and about 5 meters in width at the mouth. There is no ecotone.

Sampling Design

Both streams were mapped and divided into 30-meter-long reaches from the mouth to the headwaters. The streams were then divided into treatment sections based on similar habitat and reaches were randomly chosen in each for detailed analysis.

Population estimates:

Population estimates were done in each experimental reach. Reaches were blocked with quarter-inch mesh seine nets at the upstream and downstream

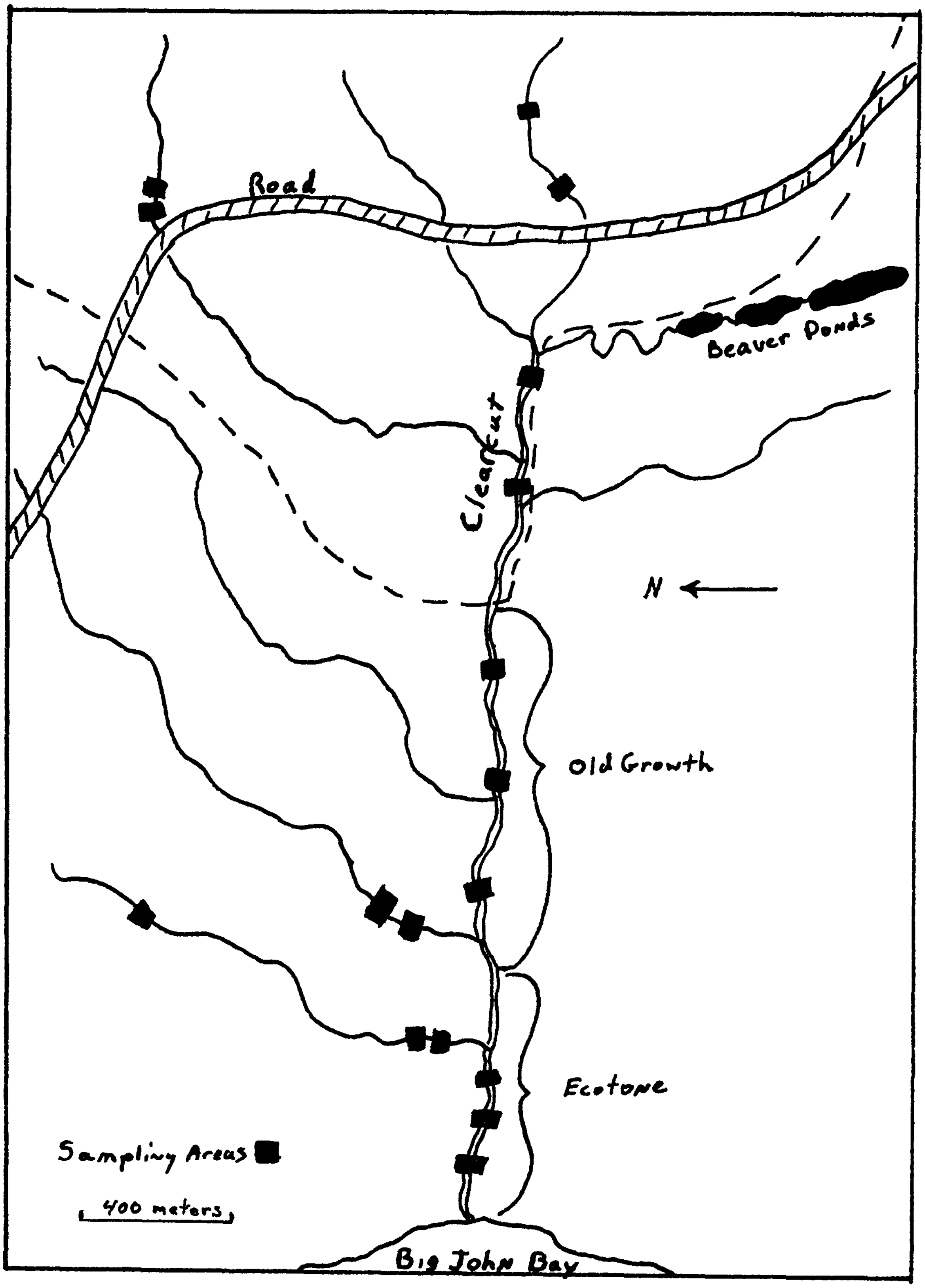

Figure 1. Kake Bake Creek, Kupreanof Island, showing the location of treatments and sampling reaches.

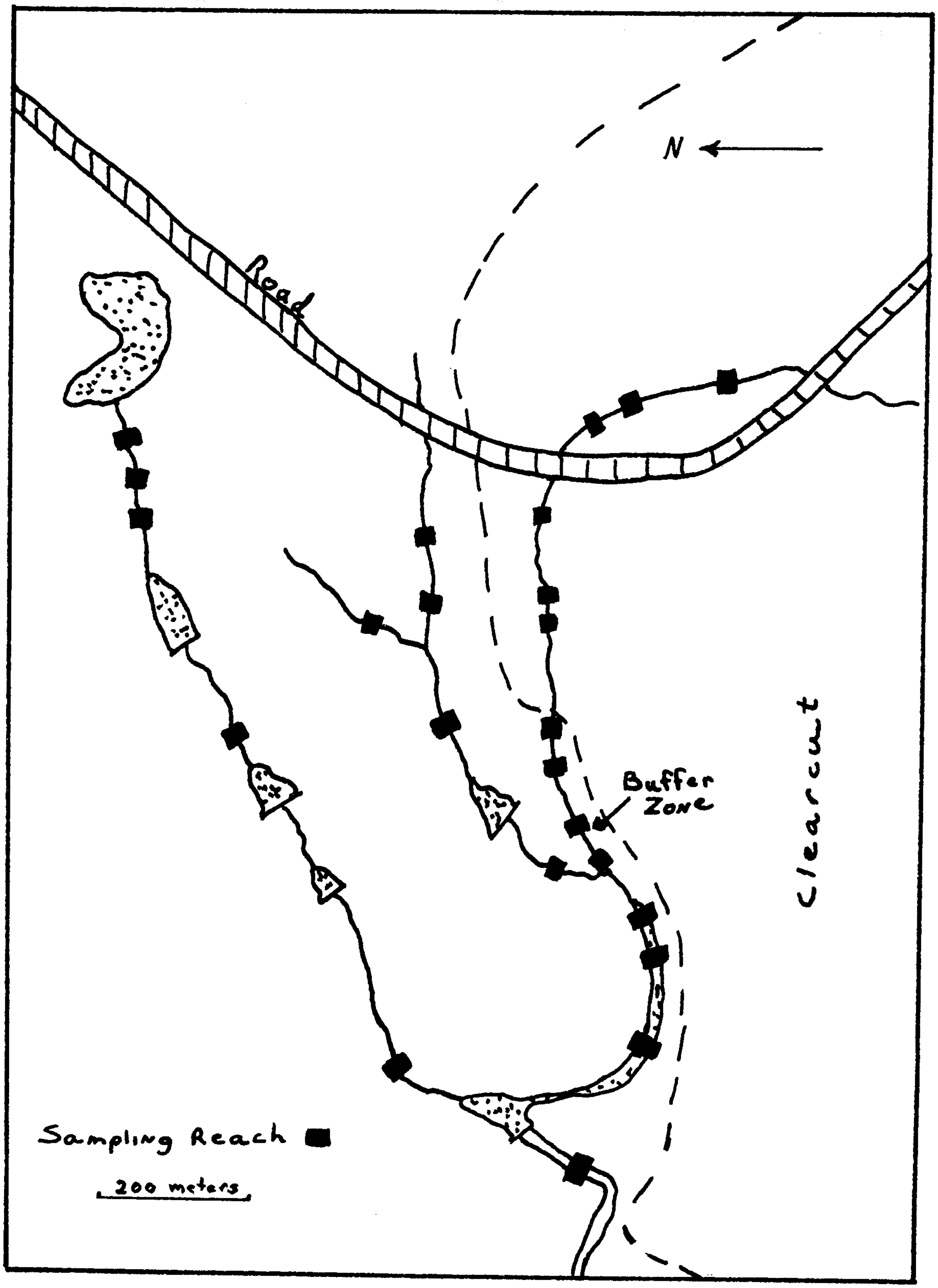

Figure 2. Deer Track Creek, Prince of Wales Island, showing the location of treatments and sampling reaches.

and fish were captured with a generator powered Smith Root backpack shocker. Fish were given a distinctive mark, either by removing the tip of the upper or lower caudal lobe or by using a small hole punch made from a hypodermic needle. They were measured to the nearest 1mm fork length, weighed to the nearest 0.1 gram, and released. After waiting 2 to 3 hours, the reach was shocked again and recovered fish were examined for marks and an estimate using Chapman's modification of the Peterson estimate was calculated.

Habitat Measurements:

Habitat was evaluated using a transect method. Transects were established at 3 meters along the length of the reach. The types of stream habitat occurring on the transect was described using classification of Bisson et al. (1983) and the distance along the transect of each habitat type was measured. When pools occurred on the transect, the volume was calculated by measuring depth at four points across the width of pool and along its length. Multiplying the area derived from the length and width by the two cross sections gave the pool volume.

The volume of large organic debris (¢10 cm dia, ¢1 m long) occurring on the transect was measured by obtaining the length of the material in the stream and multiplying it by the mean diameter. The surface area of under-cut banks was calculated by measuring the length of each under-cut on the transect and by obtaining the mean overhang distance at three locations. The discharge and gradient of each reach was determined. The temperature was recorded using two Endeco recording thermometers at each site.

Movement Studies:

Consider the following scenario:

> If estimates in treatment reaches revealed no fish after the winter period, is this due to mortality or movement out of the reach to more favorable winter habitat?.

Consequently, determination of movement was necessary to estimate mortality. This was done by giving fish captured within each treatment a distinctive fin mark in August and November. We used caudal fin clips and punches, anal clips and punches, ventral clips, and dorsal punches. Fish were recovered from all treatments in February and the number of treatment marks recovered was recorded.

FINDINGS

Movement of Coho

Movement of coho in Kake Bake Creek was minimal. Of the marked fish recovered, only 0-24% moved from their site of marking (Table 2). Those fish that did move were found in stream reaches in close proximity to their origin. Recoveries from refuge habitat (ponds) showed that only 20% were from other treatments; however, these were from treatments immediately downstream of the ponds.

Table 2. Location and Percent Composition of August Marked Coho Recovered in February, Kake Bake Creek, 1984.

Origin (August 1983)		Number, Percent, and Site of Recovery (February 1984)						
					Refuge Habitat		Tributaries	
Treatment	No. Marked	Ecotone	Old Growth	Clearcut	Ponds	Sloughs	Old Growth	Clearcut
Ecotone	330	2(4%)	7(16%)	7(16%)	16(36%)	8(18%)	2(4%)	0
Old Growth	244	0	31(76%)	5(12%)	3(7%)	0	1(2%)	0
Clearcut	383	1(1%)	0	84(76%)	7(6%)	12(11%)	2(2%)	5(5%)
Ponds	275	0	5(5%)	1(1%)	84(79%)	9(8%)	8(7%)	0

An exception were the fish marked in the ecotone area. Only 4% of the ecotone fish were found at the site of marking. Seventy percent of the ecotone recoveries occurred in the ponds and adjacent areas, indicating that fish dwelling near inter-tidal areas during summer seek refuge in freshwater areas during winter and can move long distances.

Movement of juvenile coho at Deer Track Creek was minimal (Table 3). Of the marked fish recovered only 20% had moved mostly to slough areas. Fish marked in the buffer zone also tended to move immediately downstream and reside in sloughs (42%). Fish originally marked in the ponds and slough areas tended to remain there (90%).

Movement of Dolly Varden and Cutthroat:

Dolly Varden (Salvelinus malma) were distributed primarily in the headwaters of Kake Bake Creek; the largest populations occurred in the clear-cuts and ponds. Between August and February, about 40% to 60% of the fish moved from the site of original capture to other areas of the stream or the tributaries immediately adjacent to their origin (Table 4). The cutthroat (Salmo clarki) population of this stream was very small and were not used in movement studies.

There was little movement of Dolly Varden at Deer Track Creek. Those that did move were found in areas adjacent to the origin (Table 5). Cutthroat trout showed similar pattern of movement; 54% - 92% of the fish recaptured in February were still in the treatment in which they were marked. Movement that did occur was local, either immediately upstream, downstream, or to adjacent tributaries (Table 6).

Timing of Movement:

Most movement appears to take place generally between August and November (Table 7), with little additional movement after November. Local conditions, however, seem to influence different species to varying degrees. Continual movement of coho occurred at Deer Track Creek and of Dolly Varden at Kake Bake Creek and may be related to habitat quality and climate.

Changes in Population Size

Population estimates in treatment reaches showed that numbers of fish declined from August to February in all treatments but ponds and sloughs. This indicates that a combination of winter mortality and emigration reduced numbers in most treatments and that immigration increased numbers of fish in refuge habitat (Tables 8 and 9).

Winter Survival

Recovery of marked fish was used to estimate the number of fish that entered or left a treatment section between August and February and changes in fish numbers resulting from movement could, therefore, be separated from changes caused by mortality. In Kake Bake Creek (Table 10), winter survival of juvenile coho and Dolly Varden was highest in old growth forested sections of stream and in ponds and sloughs. Survival was lowest in clear-cut portions of the stream. In Deer Track Creek (Table 11), survival of coho was highest in ponds, sloughs, and in the buffer area, but very poor in the

Table 3. Location and Percent Composition of August Marked Coho Recovered in February, Deer Track Creek, 1984.

Origin (August 1983)		Number, Percent, and Site of Recovery (February 1984)		
Treatment	No. Marked	Buffer	Clearcut	Refuge Habitat Ponds/Sloughs
Buffer	76	4(33%)	2(17%)	5(42%)
Clearcut	175	1(05%)	16(80%)	3(15%)
Ponds	256	1(02%)	3(06%)	46(90%)

Table 4. Location and Percent Composition of August Marked Dolly Varden Recovered in February, Kake Bake Creek, 1984.

Origin (August 1983)		Number, Percent, and Site of Recovery (February 1984)						
					Refuge Habitat		Tributaries	
Treatment	No. Marked	Ecotone	Old Growth	Clearcut	Ponds	Sloughs	Old Growth	Clearcut
Old Growth	4	0	0	0	1(50%)	0	0	0
Clearcut	299	0	4(11%)	22(61%)	1(03%)	1(03%)	5(14%)	1(03%)
Ponds	246	0	0	8(21%)	15(39%)	6(16%)	5(13%)	4(11%)

Table 5. Location and Percent Composition of August Marked Dolly Varden Recovered in February, Deer Track Creek, 1984.

Origin (August 1983)		Number, Percent, and Site of Recovery (February)				
Treatment	No. Marked	Buffer	Clearcut	Refuge Habitat Ponds/Sloughs	Lake Outlet	Old Growth Tributary
Buffer	65	4(57%)	0	1(14%)	0	0
Clearcut	299	2(05%)	39(91%)	0	2(5%)	0
Ponds	275	8(10%)	3(04%)	60(77%)	0	7(09%)
Old Growth Tributary	143	0	1(04%)	11(39%)	0	16(57%)

Table 6. Location and Percent Composition of August Marked Cutthroat Recovered in February, Deer Track Creek, 1984.

Origin (August 1983)		Number, Percent, and Site of Recovery (February 1984)				
Treatment	No. Marked	Buffer	Clearcut	Refuge Habitat Ponds/Sloughs	Lake Outlet	Old Growth Tributary
Buffer	97	5(56%)	1(11%)	0	0	3(33%)
Clearcut	164	2(08%)	14(54%)	8(31%)	1(4%)	1(04%)
Ponds	122	5(56%)	2(08%	21(81%)	0	2(08%)
Old Growth Tributary	95	1(04%)	0	1(04%)	0	22(92%)

Table 7. Timing of Movement at Deer Track and Kake Bake Creek August 1983 - February 1984 (Percent recoveries outside of point of origin).

Deer Track Creek

Species	Movement by Nov.	Movement by Feb.
Coho	14%	25%
Dolly Varden	22%	23%
Cutthroat	24%	24%

Kake Bake Creek

Species	Movement by Nov.	Movement by Feb.
Coho	23%	29%
Dolly Varden	19%	38%
Cutthroat	...	...

Table 8. Mean Population Levels (No./30m reach) of Salmonids by Treatment at Kake Bake Creek, August 1983 - February 1984.

Species	Treatment	August	November	February
Coho	Ecotone	48.5	1.3	1.3
	Old Growth	48.2	55.6	50.2
	Clearcut	53.3	41.9	35.5
	Ponds	182.7	428.0	173.6
	Old Growth Tributary	10.4	18.4	11.3
	Clearcut Tributary	7.7	12.6	8.0
Dolly Varden	Ecotone	1.0	1.0	1.0
	Old Growth	8.0	10.7	4.5
	Clearcut	23.5	19.0	17.0
	Ponds	92.4	94.4	28.0
	Old Growth Tributary	13.0	13.1	16.2
	Clearcut Tributary	37.0	43.4	24.5

Table 9. Mean Population Levels (No./30m reach) of Salmonids in Treatment at Deer Track Creek, August 1983 - February 1984.

Species	Treatment	August	November	February
Coho	Clearcut	27.1	19.4	7.6
	Buffer	15.3	7.4	5.9
	Ponds	24.8	61.9	38.0
	Slough	42.6	81.2	51.2
	Tribs	1.9	1.6	1.5
Dolly Varden	Clearcut	38.2	31.7	24.3
	Buffer	13.0	12.2	9.6
	Ponds	44.9	13.3	28.9
	Slough	25.8	8.3	5.4
	Tribs	12.0	3.2	3.7
Cutthroat	Clearcut	28.5	22.1	14.5
	Buffer	23.4	13.3	7.1
	Ponds	35.0	18.3	37.7
	Slough	7.6	2.7	7.0
	Tribs	16.6	11.3	9.8

Table 10. Estimated Survival of Juvenile Salmonids Adjusted for Movement at Kake Bake Creek from August 1983 to February 1984. (Populations expressed as mean no./30m reach.)

Species	Treatment	Estimated Aug. Pop.	Mean Emigration	Mean Immigration	Calculated Feb. Pop.	Estimated Feb. Pop.	Estimated %Survival
Coho	Old Growth	48.2	11.5	16.8	53.5	50.2	93.8
	Clearcut	53.3	12.7	15.8	56.4	35.2	62.4
	Ponds	182.7	38.0	24.1	168.5	173.6	77.6
Dolly Varden	Old Growth	8.0	4.0	3.6	7.6	4.5	59.2
	Clearcut	23.5	9.1	19.4	33.8	17.0	50.2
	Ponds	92.4	56.3	2.0	38.1	28.0	73.4

Table 11. Estimated Survival of Juvenile Salmonids Adjusted for Movement at Deer Track Creek from August 1983 to February 1984. (Populations expressed as mean no./30m reach.)

Species	Treatment	Estimated Aug. Pop.	Mean Emigration	Mean Immigration	Calculated Feb. Pop.	Estimated Feb. Pop.	Estimated %Survival
Coho	Clearcut	27.1	5.4	4.0	25.7	7.6	29.5
	Buffer	15.3	10.2	1.7	6.8	5.9	86.7
	Ponds	24.8	2.4	13.1	35.5	38.0	100.0
Dolly Varden	Clearcut	38.2	3.8	2.1	36.5	24.3	66.5
	Buffer	13.0	5.5	6.3	13.8	9.6	69.5
	Ponds	44.9	10.3	6.4	41.0	28.9	70.4
Cutthroat	Clearcut	28.5	13.1	5.3	20.6	14.5	70.3
	Buffer	23.4	10.2	4.2	17.4	7.1	40.8
	Ponds	35.0	6.6	9.4	37.8	37.7	100.0

clear-cut section. Survival of Dolly Varden and cutthroat trout was highest in ponds and sloughs. The results for char and cutthroat residing in buffer sections and in clear-cut sections were mixed. Both char and trout had better survival rates in clear-cuts than did juvenile coho.

There are discrepancies between the estimated populations in November and the population size calculated from movement data. This discrepancy seems to occur primarily in ponds and sloughs. This is probably a result of an inadequate number of marked fish in areas of high fish density immediately downstream of some ponds.

Fate of Coho Fry: Mortality or Smolt

The results of studies in 1982 suggest that coho fry in logged streams may incur greater rates of winter mortality than their counterparts in forested streams or that they may be leaving the stream as age-1 smolt.

The above cannot be addressed at the time of this writing, as neither age analysis nor smolt work has been completed. The results of that work will be reported in the FY 85 Annual Report of Performance.

Winter Temperature Monitoring

Model J-180 Ryan recording thermometers were installed at the 10 logged and 10 forested study sites that were investigated during the summer of 1982 to monitor water and air temperature from November 1982 to April 1983. About 30% of the thermometers failed during the measurement period; others produced inaccurate data. The data produced by instruments that worked reliably showed no consistent difference between thermal regimes of logged and forested streams. Since the accuracy of all data is suspect, the results of the study are inconclusive.

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